Claims

1. A roll angle estimation apparatus for predicting a future roll angle of a vehicle, said apparatus comprising:

an angular accelerometer for sensing angular acceleration of a vehicle and producing an output signal indicative thereof;

an integrator for integrating the sensed angular acceleration signal and producing an angular rate; and

a predictor for predicting a future roll angle of the vehicle as a function of the sensed angular acceleration, the angular rate, and a current roll angle.

2. The apparatus as defined in claim 1, wherein the current roll angle is determined by integrating the angular rate.

3. The apparatus as defined in claim 2, wherein the predictor comprises a Taylor series-based predictor for predicting the future roll angle as a quadratic extrapolation.

4. The apparatus as defined in claim 1, wherein the angular accelerometer senses roll angular acceleration about a longitudinal axis of the vehicle, and said predictor predicts the future roll angle about the longitudinal axis.

5. The apparatus as defined in claim 5, wherein said integrator and predictor are performed by a controller.

6. The apparatus as defined in claim 5, wherein said controller further compares the predicted future roll angle to a threshold value and predicts an anticipated vehicle overturn condition based on the comparison.

7. The apparatus as defined in claim 1, wherein the predictor performs a quadratic extrapolation.

8. The apparatus as defined in claim 1, wherein the integrator performs a numerical integration of the angular acceleration signal based on time steps that vary as a function of rate of change of the acceleration signal.

9. The apparatus as defined in claim 1, wherein the integrator performs a numerical integration of the angular acceleration signal based on time steps that vary as a function of magnitude of the acceleration signal.

10. A rollover sensing apparatus for predicting an overturn condition for a vehicle, comprising:

an angular accelerometer for sensing angular acceleration of a vehicle and producing an output signal indicative thereof;

an integrator for integrating the sensed angular acceleration signal and producing an angular rate;

a predictor for predicting a future roll angle of the vehicle as a function of the sensed angular acceleration, the angular rate, and a current roll angle;

a comparator for comparing the predicted future roll angle to a threshold value; and

an output for generating an output signal indicative of an anticipated vehicle overturn condition prediction based on said comparison.

11. The apparatus as defined in claim 10, wherein the current roll angle is determined by integrating the angular rate.

12. The apparatus as defined in claim 11, wherein the predictor comprises a Taylor series-based predictor for predicting the future roll angle as a quadratic extrapolation.

13. The apparatus as defined in claim 10, wherein the angular accelerometer senses roll angular acceleration about a longitudinal axis of the vehicle, and said predictor predicts the future roll angle about the longitudinal axis.

14. The apparatus as defined in claim 10, wherein said integrator, predictor, and comparator are performed by a controller.

15. The apparatus as defined in claim 10, wherein the predictor performs a quadratic extrapolation.

16. The apparatus as defined in claim 10, wherein the integrator performs a numerical integration of the angular acceleration signal based on time steps that vary as a function of rate of change of the acceleration signal.

17. The apparatus as defined in claim 10, wherein the integrator performs a numerical integration of the angular acceleration signal based on time steps that vary as a function of magnitude of the acceleration signal.

18. A method for estimating a future roll angle of a vehicle, said method comprising the steps of:

sensing angular acceleration of a vehicle and producing an output signal indicative thereof;

integrating the sensed angular acceleration signal to generate an angular rate;

obtaining a current roll angle;

predicting a future roll angle as a function of the sensed angular acceleration, the angular rate, and the current roll angle.

19. The method as defined in claim 18, wherein the step of obtaining the current roll angle comprises integrating the angular rate.

20. The method as defined in claim 18 further comprising the steps of:

comparing the predicted future roll angle to a threshold value; and

generating a vehicle overturn condition signal based on said comparison.

21. The method as defined in claim 18, wherein said step of integrating comprises:

determining a rate of change of the acceleration signal;

computing a time step as a function of the rate of change of the acceleration signal; and

performing numerical integration of the acceleration signal based on the computed time step.

22. The method as defined in claim 18, wherein the step of integrating comprises:

determining a magnitude of the acceleration signal;

computing a time step as a function of magnitude of the acceleration signal; and

performing numerical integration of the acceleration signal based on the computed time step.

23. The method as defined in claim 18, wherein the step of sensing angular acceleration comprises sensing roll angular acceleration about a longitudinal axis of the vehicle.

24. The method as defined in claim 18, wherein the step of predicting a future roll angle comprises computing a Taylor-series quadratic function.

25. A method for predicting an overturn condition of a vehicle, said method comprising the steps of:

sensing angular acceleration of a vehicle and producing an output signal indicative thereof;

integrating the sensed angular acceleration signal and producing an angular rate;

obtaining a current roll angle;

predicting a future roll angle as a function of said sensed angular acceleration, said angular rate, and said current roll angle;

comparing the predicted future roll angle to a threshold value; and

generating a vehicle overturn condition signal based on said comparison.

26. The method as defined in claim 25, wherein the step of obtaining the current roll angle comprises integrating the angular rate.

27. The method as defined in claim 25 further comprising the steps of:

comparing the predicted future roll angle to a threshold value; and

deploying a vehicle overturn condition based on said comparison.

28. The method as defined in claim 25, wherein said step of integrating comprises:

determining a rate of change of the acceleration signal;

computing a time step as a function of the rate of change; and

performing numerical integration of the acceleration signal based on the computed time step.

29. The method as defined in claim 25, wherein the step of integrating comprises:

determining a magnitude of the acceleration signal;

computing a time step as a function of magnitude of the acceleration signal; and

performing numerical integration of the acceleration signal based on the computed time step.

30. The method as defined in claim 25, wherein the step of sensing angular acceleration comprises sensing roll angular acceleration about a longitudinal axis of the vehicle.

31. The method as defined in claim 25, wherein the step of predicting a future attitude angle comprises computing a Taylor-series quadratic function.